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ABSTRACT -- KEY POINTS

The semiempirical models for BRDF function fitting continue to acquit themselves well when tested on BRF measurements from various land cover types. The Li-Strahler mutual shadowing model, which provides the basis for two of the semiempirical kernels, fits both lab and field data from the CASI instrument well. Both albedo and semiempirical-parameter retrievals are not overly sensitive to noise in input measurements. The BRDF/Albedo product ATBD was completely rewritten and made available to the project on May 15. Coding for the Beta-3 delivery began late in the period.

Algorithm development for the land cover and land-cover change products continued with the assembly of a multidate TM database for the Walnut Gulch region of Arizona. Further data development awaits the receipt of better ground truth maps. Possible feature selection strategies were reviewed in the literature. Applications of neural net classifiers to the mixed pixel problem and to change detection were explored. Coding for the Beta-3 delivery began late in the period.

TASK PROGRESS

BRDF/Albedo Product

Model Development

During the reporting period, we continued our development of semiempirical models of bidirectional reflectance. This culminated with the submission of a paper to the Journal of Geophysical Research documenting the mathematical derivation and properties of the semiempirical kernels.

Model Validation

We also continued BRDF model validation activities by further work with the bidirectional reflectance data for eleven land cover types as provided by Dan Kimes of Goddard Space Flight Center. We also fit the semiempirical models to new suites of data acquired under our direction in July, 1994, at the Solar Simulation Laboratory, Changchun, China. The results were summarized in a proceedings paper for presentation at IGARSS'95 in July.

Additional validation efforts involved collaboration with John Miller and Ray Soffer, at York University, on a comparison of the Li-Strahler mutual shadowing model with observations using the CASI sensor made in Miller's laboratory on a forest of artifical trees. The model acquited itself well. The results were written up for publication under joint authorship as a proceedings paper for presentation at IGARSS'95 in July.

In a collaboration with Robert d'Entremont of USAF Phillips Labs, we developed a plan for acquisition of cloud-cleared AVHRR data for the New England region with the objective of testing the ability of the Ambrals semiempirical models to capture the shape of land BRDFs over large regions. This will be largely top-of-atmosphere data, but atmospheric correction may also be attempted.

Software and Algorithm Development

During the second quarter of the reporting period, the development of beta-delivery software began in earnest. This required major investments of science time in coding the algorithm and dealing with the PGS toolkit. During this time, Ambrals was also recoded and rereleased to be consistent with the MODIS algorithm.

Atmospheric Correction-BRDF Effects

In collaboration with Eric Vermote, we continued developing the BRDF-atmospheric correction loop plan for MODIS, including the concept of Level 2G data -- forward binned, but unresampled values placed into the Level 3 grid.

Sensitivity Studies

Using a theoretical approach, we explored the sensitivity of the retrieval of semiempirical model parameters and albedo to noise in the directional observations. We found that for a noise level of 5 percent, we found that parameters were retrieved with 1-4 percent accuracy for practical cases and albedo was retrieved with accuracies less than 2 percent.

ATBD Revision

The ATBD document was totally rewritten during a four-month period, and the revised document (Version 3.2) was released to the project on May 15.

Land Cover/Land-Cover Change

During this reporting period, we focused primarily on algorithm development for land cover classification. We continued our work with advanced technology (AT) classifiers -- neural nets, decision trees, adaptive classifiers, etc.

Walnut Gulch

We received a series of TM images and some ground truth information on the Walnut Gulch site from Team Member Alfredo Huete's group, and spent considerable time registering and radiometrically correcting a time sequence of six selected TM datasets. We then began an exploration of neural network and tree-base classifiers. However, the quality of the ground truth information was limiting, and a new set of ground truth data was expected to be available shortly. Thus, we halted work with this dataset, pending the receipt of a new land cover map for the area.

Feature Selection

A problem with MODIS data is that its multiple information domains provide a very large number of variables -- "features" -- that are observed for each pixel over the course of an annual cycle. This information must be reduced and stripped of redundancy for a classifier to use it effectively. An important activity in the latter part of the reporting period was a survey of the artificial intellegence and remote sensing literatures for fast and effective techniques for feature selection.

MAS-BOREAS Data

We requested the navigated and resampled MODIS Airborne Simulator (MAS) data from BOREAS from BORIS, but were unable to secure it during the reporting period. The objective was

to provide a land-cover type classification using advanced-technology classifiers from MAS imagery and ground truth provided by the BORIS.

Neural Nets

Research on neural net classifiers continued with completion of a study on using neural net classifier outputs to indicate mixed pixels. In other work, fuzzy ARTMAP was used successfully for change detection in a database of TM imagery for the Tahoe National Forest.

Algorithm Coding

Coding of the land-cover algorithm required a major effort during the period. Initial coding strategies were developed late in the reporting interval.

ANTICIPATED ACTIVITIES DURING THE NEXT QUARTER

BRDF/Albedo Product

Our primary activity during the next quarter for the BRDF/Albedo product will be to code the Beta-3 version of the algorithm, integrating the Toolkit and related subroutines. We will also continue refining the application of the semiempirical models, their validation, and their use to calculate albedo in realistic MODIS-MISR sensing scenarios.

Land Cover/Land-cover Change Product

During the next quarter, we will continue to code the Beta-3 version of the land-cover algorithm in the ESDIS environment. This will include both the monthly algorithm, which prepares a monthly database, and the classifier itself, which reads a year of monthly databases and provides a classified product every three months. In land-cover change activities, we will continue our liaison with Eric Lambin at the European Economic Community's Joint Research Center. Activities there focus on land-cover change as inferred from a ten year record of African AVHRR observations.

PROBLEMS/CORRECTIVE ACTIONS

During this reporting period, we did not encounter any significant problems requiring corrective actions beyond the everyday problems that occur in research and algorithm development.

PUBLICATIONS

Attached below is an updated list of publications derived with full or partial support under this contract. Items marked with an asterisk are new publications that are being submitted separately in hardcopy to the project management.

MASTER MODIS PUBLICATION LIST

July 1, 1995

Submitted

Schaaf, C. B. and A. Strahler, 1996, Modeling the hemispherical reflectances of a mountainout forst landscape using geometric-opticas and a distributed parameter approach, submitted to Remote Sens. Env. (May, 1995)

In Press

Strahler, A. H., 1995, Vegetation canopy reflectance modeling -- Recent developments and remote sensing perspectives, Remote Sens. Rev., in press.

Wanner, W., X. Li, and A. H. Strahler, 1996, On the derivation of kernels for kernel-driven models of bidirectional reflectance, J. Geophys. Res., in press.

Moody, A. and Woodcock, C. E., 1995, The influence of the spatial characteristics of landscapes on land-cover mapping using remote sensing, Landscape Ecology, in press.

Woodcock, C. E., J. B. Collins, and D. L. B. Jupp, 1995, Scaling remote sensing models, in Scaling Up, P. van Gardingen, G. Foody, and P. Curran (eds.), Society of Experimental Biology, Cambridge University Press, in press.

Wang, J., X. Li, and A. Strahler, 1995, Tree tomography--an indirect method for measuring crown structure, Proc. of GeoInfomatics'95, in press.

Strahler, A., W. Wanner, Q. Zhu, and X Jin, 1995, Bidirectional reflectance modeling of data from vegetation obtained in the Changchun solar simulation laboratory, Proc. 15th Int. Geosci. and Remote Sensing Symp., Florence, Italy, July 10-14, 1995, in press.

Soffer, R. J. Miller, W. Wanner, and A. Strahler, 1995, Winter boreal forest canopy BRF results: Comparisons between airborne data, laboratory simulations and geometrical-optical model data, Proc. 15th Int. Geosci. and Remote Sensing Symp., Florence, Italy, July 10-14, 1995, in press.

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Liang, S. and A. H. Strahler, 1995, An analytic radiative transfer model for a coupled atmosphere and leaf canopy, J. Geophys. Res., in press.

Li, X., A. H. Strahler, and C. E. Woodcock, 1995, A hybrid geometric optical-radiative transfer approach for modeling albedo and directional reflectance of discontinuous canopies, IEEE Trans. Geosci. and Remote Sens., in press.

Published

*Li, X., R. Davis, and C. Woodcock, 1994, A hybrid geometric optical and radiative transfer approach for modeling pyranometer measurements under a jack pine forest, Geographic Information Sci., vol. 1, pp. 27-34.

*Moody, A. and Woodcock, C. E., 1995, Calibration-based methods for correcting coarse resolution estimates of land-cover proportions, Proc. 61st Ann. Convention Amer. Soc. Photogrammetry and Remote Sens., Charlotte, NC, Feb. 27-March 2, 1995, vol. 3, pp. 684-693.

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